Young Faculty Award (YFA) Workshop

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Overview of DARPA Programs I have initiated/managed

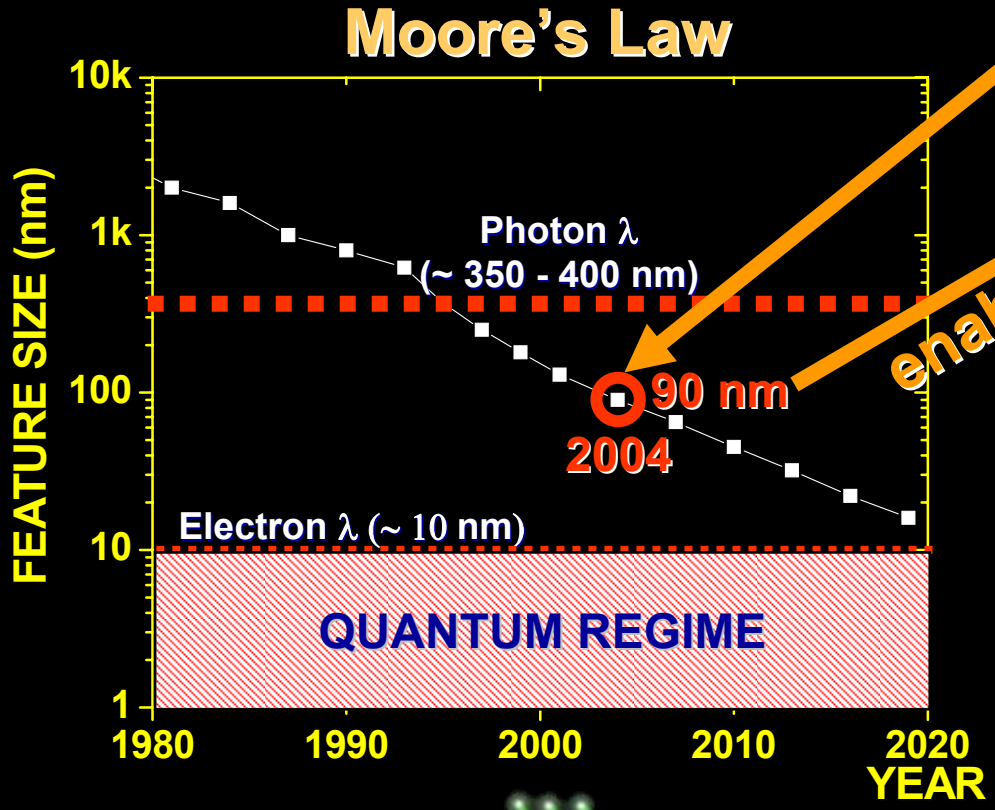
PROGRAM	COMMENTS
ABCS	*Electronics*; transferred to Mark Rosker; completed
CS-WDM	*Photonic Integration*; Multiple WDM functions on a chip; near completion
O-CDMA	*Optical Networks*; Optical Code Division Multiple Access; photonic technology, algorithms, sytems; tranferred to Henryk Temkin
DOD-N	*Optical Packet Switching*; Aggressive photonic integration; tranferred to Mike Haney
EPIC	*Electronic and Photonic Integrated Circuits* on Si
UPR	University Photonic *Research Centers*
UNIC	Nanophotonic *Intrachip Communications*
QUANTUM INFORMATION	Understand and exploit the essential *quantum nature*; convergence of quantum mechanics and information science

Dealing with DARPA

- DARPA is Projects oriented: different from other agencies
- Two types of funding
  - Seedling funds
  - Becoming a part of a project
- Presenting your great research idea is not enough
  - Where does it fit in?
  - What is its impact?
  - Help DARPA Program Manager create a vision for the program
- Heilmeir Questions
  - What are you trying to do? What is the problem you are trying to solve?
  - How is it done today, and what are the limitations of current practice?
  - What is new in your approach, and why do you think it will be successful? What gives evidence that it will work?
  - Assuming you are successful, what difference does it make?

EPIC

Electronic/Photonic Integrated Circuits



An Extraordinary OPPORTUNITY

enables

Silicon Nanophotonics

- Small index contrast makes current devices very large
- Large index contrast in Si/SiO_2 + 90 nm fab capabilities (e.g. smooth walls) → nanophotonics
- Fine Feature Size
  - Essential for very high speed

PIGGYBANK ON CMOS INFRASTRUCTURE AND PROGRESS

Silicon Nanophotonics
+
CMOS Electronics

Monolithically Integrated VLSI Photonics and Electronics on a single Silicon Chip In a standard CMOS-SOI Foundry

Seamless Photonics-Electronics interface

DARPA's EPIC PROGRAM

- Four Year Program in three phases
- Kicked off in December 2004
- Focus on
  - Complete suite of high performance Si nanophotonic devices
  - Demonstrate an application specific EPIC chip
  - Novel Devices

- Luxtera
- BAE Systems
- MIT/MIT-LL
- Caltech
- UCLA
- Translucent
- U of Michigan
- Brown University

Program Objectives

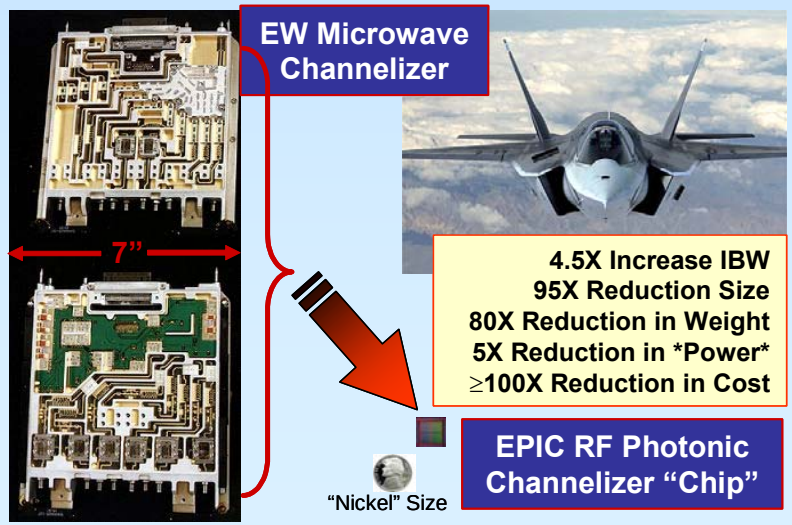
To demonstrate a densely integrated "Application Specific Electronic Photonic Integrated Circuit" (AS-EPIC) using an electronic warfare (EW) application as a demonstration vehicle.

Approach

Integrate the best technology and designs from BAE Systems, Lucent Technologies, MIT, and AWR to realize our AS-EPIC chip. This involves combining CMOS compatible, low loss, high index contrast (HIC) waveguides and electro optic components to form optical filters, modulators, and detectors.

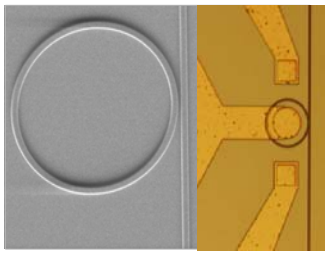
Tasks

- Develop an integrated broadband (HF through Ku bands) RF-photonic receiver that can intercept and monitor individual emitters.
- Create an open-architecture optical component library that is completely compatible with CMOS processes .
- Fab devices at BAE Foundry and characterize at team test facilities

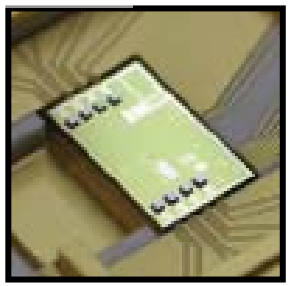


MIT MICROPHOTONICS CENTER

New Program Direction



EPIC Devices



EPIC Circuits

UNIC Circuits

Intra-chip optical communications

- 2D AND 3D SYSTEMS ARE BECOMING ULTRADENSE
  - MOORE'S LAW → 10^{12} TRANSISTORS PER CM^2
    - 3D ELECTRONICS
  - 10^{12} MOLECULAR UNITS PER CM^3
- HOW DO THESE UNITS COMMUNICATE
  - WITH EACH OTHER?
  - WITH THE OUTSIDE WORLD?

THIS IS A FORMIDABLE CHALLENGE
VISION: DEVELOP A PATHWAY FOR SUCH COMMUNICATIONS

STRATEGY
FOCUS ON INTRA-CHIP COMMUNICATIONS ON A HIGH PERFORMANCE ELECTRONIC CHIP

- The technologies needed to realize this vision are very different from those for other optical communications (WAN, MAN, LAN etc.)
- If successful, this technology will enable ultrahigh performance interchip communications
- This will be a game-changing, disruptive technology

Summary

- DARPA is a challenging and exciting organization
- Conceiving and developing a new program is the part I have enjoyed the most at DARPA
- You must invest the time in “learning the ropes” if you want to engage in DARPA’s programs
- I will be happy to meet with you during this workshop, and discuss your ideas and thoughts